

## **CORRELATION BETWEEN LOCAL AMPLIFICATION EFFECTS AND DAMAGE MECHANISMS FOR MONUMENTAL BUILDINGS**

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### **SCOPE**

Vulnerability analysis for monumental buildings may be carried out on different levels of knowledge, that show a greater level of in-depth knowledge, as a function not so much of the used method (macroseismic or mechanical approach), but of the accuracy and the typology of the available information. When physical parameters (peak acceleration, spectral velocity) are available it is possible to use mechanical models, closer to a purely engineering approach. On the other hand, when historical earthquakes are studied, the lack of instrumental information leads necessarily to a hazard description by means of an intensity scale. The two approaches are based respectively on the definition of a vulnerability index and of a capacity curve, that are refined on the individual building as a function of the analysis level adopted in the survey. The two methods and the results obtained are comparable to each other: it is indeed possible to pass from the variables of one method to those of the other by means of empirical correlations. The dual approach allows the definition of a risk scenario congruent with the analysis method adopted and the results obtainable are a function of the level of data knowledge. In particular, the authors want to highlight how it is possible to take into consideration the local seismic amplification in both the methods: in the mechanical approach it can be implicitly considered in the modelling, whereas in the macroseismic model the topographical amplification can be taken into account through the definition of a behaviour modifier, connected to the morphological site conditions, since the seismic hazard is all included in the single parameter "intensity".

### **METHODOLOGY**

The damage and the vulnerability survey of the monumental buildings, damaged by the 2002 earthquake in Molise Region, has allowed to single out a correlation between the observed damage of the churches and their morphological site conditions, represented through simplified parameters, considering three model-situations. The vulnerability model connected to the survey methodology provides an evaluation of the expected mean damage.

The comparison with the observed damage determined the introduction of a local morphological behaviour modifier, able to take into account the vulnerability increase due to the site effects.

In order to validate the previous results, a numerical analysis 2D of the seismic local response has been performed, for the churches sites. In particular, on the analyzed situations a numerical code, working with boundary elements, has been applied. The results, in term of pseudo-acceleration response spectra and amplification factors, allow to compare the numerical and the observed analyses.

### **RESULTS**

The topographic analysis carried out on several churches struck by the earthquake has allowed to evaluate some geometric parameters for the more recurrent morphological situation (the ridge). They could be synthesized in a local morphological vulnerability modifier ( $\Delta V_{ml}$ ), that represents an additional parameter to take into account in vulnerability analyses (macroseismic approach).

The results of the numerical analysis 2D, in terms of amplification factors ( $Fa$ ) calculated in the periods of 0.1-0.5 s, show high values of  $Fa$  related to high values of  $H/L$ , where  $H$  is the maximum height and  $L$  is the maximum width of the studied ridge. The period 0.1-0.5 s has been considered representative of the dominant period of the analyzed churches.

The comparison between the different approach confirms a discrete agreement between the local morphological vulnerability modifier ( $\Delta V_{ml}$ ) and the amplification factor ( $Fa$ ), although some unavoidable differences.